Grass Hedge Effects on Gully Hydraulics and Erosion

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Grass hedges are dense, erect, vegetative barriers made of large-stemmed erect-growing grass such as switchgrass (*Panicum virgatum*). Previous flume tests have demonstrated the ability of hedges to produce head losses exceeding 0.5 m per hedge. Use of a series of such hedges planted on the contour at 0.5-m vertical intervals in gullies represents a cost-effective, environmentally attractive alternative to more traditional types of erosion control structures. Work by others suggests gullies vegetated with grass hedges might provide valuable wildlife habitats and retention of nonpoint source pollutants.

Herein we report results of twelve field tests showing the efficacy of established hedges in controlling erosion in natural and artificial gullies. Four tests were conducted in a natural gully ~10 m wide by 3 m deep in sandy, highly erodible soil, and four similar tests were conducted in each of two manmade channels ~2.3 m wide by 0.7 m deep dug in compacted fill (artificial gullies). Maximum slope for the natural gully was about 35% while the artificial channels had uniform slopes of about 40%. The natural gully mouth terminated in a 2-m high headcut while the artificial channels terminated in 1-m high headcuts left from previous flow tests. Grass hedges were established at 0.5-m vertical intervals in all three channels for two years prior to testing. Flow tests consisted of pumping water into each of the three gullies to create four trapezoidal-shaped hydrographs with discharge rates ranging from 0.04 to 0.13 m^3s^{-1} and durations ranging from 0.5 to 3 hr. Maximum unit discharges were on the order of 0.2 m^2/s^{-1}, and test hydrographs were similar to those observed for natural events. Erosion was monitored visually, by surveying channels between events, and by monitoring turbidity of water flowing in the channels. Soil water potential was monitored at three depths below the gully bed. Water discharge was measured at the entrance to each gully, and flow depth and depth-averaged velocity were logged at four points along the centerline of each gully.

Flow patterns differed between the artificial and natural gullies. The more uniform, dense hedges in the artificial gullies produced deeper, more uniform backwater pools and overflows characterized by well-defined nappes with much higher velocities than for the natural gully. Gaps in the natural gully hedges allowed passage of flow with less backwater than for the artificial channels. In all cases, hedges were effective in producing non-eroding flow conditions within the main body of the gully. After an initial flush, turbidity levels were low, and mean thalweg degradation was limited to 5-10 cm. However, the lowest grass hedge in the natural channel was not effective in controlling advancement of the 2-m high headcut. Conversely, the 1-m headcuts in the artificial channel were stable during these tests. Mechanics of headcut advancement were successfully reproduced using a numerical model that indicated grass hedges would not control headcuts higher than ~1 m under the soil and moisture conditions observed here. Our findings suggest that well-maintained grass hedges hold great promise as low-cost environmentally friendly gully erosion controls.